Evaluation of Web Accessibility of Consumer Health Information Websites

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The objectives of the study are to construct a comprehensive framework for web accessibility evaluation, to evaluate the current status of web accessibility of consumer health information websites and to investigate the relationship between web accessibility and property of the websites. We selected 108 consumer health information websites from the directory service of a Web search engine. We used Web accessibility specifications to construct a framework for the measurement of Web Accessibility Barriers (WAB) of website. We found that none of the websites is completely accessible to people with disabilities, but governmental and educational health information websites exhibit better performance on web accessibility than other categories of websites. We also found that the correlation between the WAB score and the popularity of a website is statistically significant.

INTRODUCTION

The Internet is an increasingly important resource of health information consumer. One recent study estimated that 73 million US residents search for health information online during the year 2002 [1]. Moreover, the distribution of the online population is becoming representative of the general population in relation to demographic and socioeconomic distribution. Seventy-odd percent of the population are estimated to search online for health-related information for their decision making.

The ability to obtain accurate medical information online quickly, conveniently, and privately provides health consumers with the opportunity to make more informed decisions and participate more actively in their personal care. Little is known, however, about whether this online information is accessible to people with disabilities who have to rely on special devices or technologies to process online information due to their sensory, mobile, or mental limitations.

The most recent report from the Department of Commerce on the Internet use demonstrated that people of all ages, races, and ethnicities including people with disabilities are moving more and more of their activities online [2]. A recent important study on the use of Internet by people with disabilities found that this population is far less likely than those without disabilities to use the Internet [3]. The gap is striking: people without disabilities are four times more likely (38.1%) than people with disabilities (9.9%) to use the Internet. Similar patterns remain even when factors such as income, gender, and educational attainment are taken into account. The large gap in Internet usage can be attributed in large part to problems with accessibility. A recent study by the Nielsen & Norman Group found that the usability of the Web is about three times better for users without disabilities than it is for users with disabilities [4].

For people with disabilities, the Web very often is the only source of information and knowledge to which they may have access without having to depend unduly on others. Greater access to health information over the Internet will open a door to people with disabilities by offering them the exciting possibilities for independence and community participation by overcoming environmental barriers. People with disabilities find a wealth of information on the Internet that addresses many issues of special concern to them, including chronic disease information, and rehabilitation and assistive technology services [5]. But, for health information Websites to be of real use to people with disabilities, they must be accessible at first. Health information websites are classic example of "inverse information law": access to appropriate information is particularly difficult for those who need it most [6].

An accessible consumer health information website will serve to assist in raising the independent living, community participation, and quality of life of people with disabilities. People with visual impairments, about 10 million in the United States [7], face the most serious barriers with inaccessible websites. Jacob Nielsen has observed, "The most serious accessibility problems given the current state of the Web probably relate to blind users and users with other visual disabilities since most Web pages are highly visual" [8]. Traditional website formats are often not appropriate for browsers designed for people with visual impairments.

The objectives of this study are to establish a comprehensive methodological framework for evaluating accessibility of consumer health information websites, to identify the current state of Web accessibility among consumer health information websites, and to explore the relationship between the accessibility and other features of a

website such as function, popularity, and importance. Web accessibility means access to the web by everyone, regardless of disability [9]. Consumer health information websites include websites that provide health related information to patients and to public in general [6].

METHOD

Design

Our study is primarily a cross-sectional descriptive study with concentration on the Web accessibility of consumer health information websites. We used established Web accessibility specifications as the foundation for constructing the measurement framework. In addition to the evaluation of Web accessibility, we investigated the relationship between Web accessibility and other features of websites including categories of function, popularity, and importance.

Sampling method

The unit of analysis in the study is the individual website providing health related information for consumers. Because the number and distribution of websites are not determinable due to the size and dynamics of World Wide Web (WWW), probabilistic sampling methods, such as random or stratified sampling, are not applicable under this circumstance. We employed a convenient sampling method to procure the consumer health information websites from the Internet. First, we defined the types of the websites according to their functions. We used a taxonomy that classifies the websites into 6 categories—E-commerce, corporate, government, portal, community and education. An E-commerce website is that conducts online transaction of health related products. A Corporate website represents a health care service corporate online. Government and education website are sites with postfix ".gov" and ".edu" in their domain names. A Portal website provides patients the entrance to various health related information resources. A Community website is an online place that hosts online activities of patients or health information seekers.

Then, we acquired a list of consumer health websites from the directory service of search engine Google™. Google™'s directory service is produced by the Open Directory Project that is the largest, most comprehensive human-edited directory of the Web [10]. Websites under the directory "Health: Resources: Consumer" were used as the potential consumer health information websites for evaluation. Two evaluators individually assigned each website to one of the aforementioned categories. If there is a disagreement about the assignment, both authors will discuss it until reaching a consensus. Websites that are no longer active or have changed to other content areas were excluded from the list.

Measures

1. Measurement of Web accessibility

One of the objectives of the study is to construct a measurement framework to assess the accessibility of consumer health information websites. Two major specifications are widely referenced for accessible Web content design. The first—the World Wide Web Consortium (W3C) Web Content Accessibility Guideline 1.0 (WCAG)—is a stable international specification developed through a voluntary industry consensus. The US Access Board published the second specification—Electronic and Information Technology Accessibility Standards—in December of 2000, pursuant to the US rulemaking process as required by Section 508 of the Rehabilitation Act Amendments of 1998 [11]. Both specifications offer checkpoints that Web developers should follow with regard to content accessibility for people with disabilities. These two specifications largely overlap—only three checkpoints defined in Section 508 are unmentioned in WCAG guideline 1.0. However, Section 508 is the law that requires federal agencies to comply while WCAG is only a recommendation from W3C with no legal obligation.

The number of violations of each checkpoint in both specifications is the basis of our scoring system called web accessibility barrier (WAB) score. For example, a Web page with fewer violations of Web accessibility checkpoints, e.g., providing no alternative description for image object will be considered has fewer barriers for people with disabilities and scores lower in WAB.

Because we are more interested in automatically evaluating the level of Web accessibility of a website, those Web accessibility checkpoints demanding manual checking are not included in calculating our WAB score. For example, conformance to the rule "If you use color to convey information, make sure the information is also represented another way" not can be verified until a manual check is done. For a list of Web accessibility rules that can be automatically checked, please see the WAI references [9].

WCAG guideline attaches a priority level to each checkpoint based on the checkpoint's impact on accessibility. Priority 1 checkpoints mandate the largest level of compliance while priority 3 checkpoints are optional for Web content developers. We used the 3 point priority level in reverse as the weighting factor for the calculation of WAB score. Priority 1 violations will weight 3 times heavier than the priority 3 violations because people with

disabilities have more difficulties to access the webpage with priority 1 violation.

However, using only the number of violations of Web accessibility checkpoints may bias the result the measurement. For example, the Web page with five "image without alternative text" violations may have 500 image objects embedded in the page and the Web page with one "image without alternative text" violation may have only one image object in the page. The developer of the first page may have already paid much attention to and put large effort into complying with the Web accessibility specifications while the developer of the second page may be unaware of Web accessibility at all. Therefore, the number of actual violations must be normalized against the potential violations. In the last example, true violations are the image objects without alternative text, and the potential violations include all image objects in the page. Sequentially the score of WAB for each Web site will be the summed WAB score of Web pages normalized against total number of pages.

Figure 1 summarizes the calculation of WAB score of a website as a formula. Higher score means more accessibility barriers to the people with disabilities. Lower score indicates better conformance to the Web accessibility guidelines. A score of zero means the website does not violate any Web accessibility guidelines and must have no accessibility barrier to people with disabilities.

$$WABScore = \frac{\sum_{p}\sum_{v}(\frac{n_v}{N_v})(w_v)}{Np}$$

p : Total pages of a website

v : Total violations of a web page

n_v : Number of violations

N_v : Number of potential violations

W_v : Weight of violations in inverse proportion to WCAG prority.

Np : Total number of pages checked

Figure 1: Formula for calculating WAB score

We employed several program tools to examine the true and potential violations of the Web pages. Bobby is a program tool that can examine a Web page and report violations of Web accessibility checkpoints [12]. It is the most well-known accessibility checking software and has been around longest. The desktop version can check the compliance with WCAG of a whole website or certain layers from the homepage. The newest version can check non-compliance issues with both WAI and Section 508 checkpoints. After the website is examined, Bobby generates a report in eXtensible Markup Language (XML) format that can be further processed to obtain data about true violations. The data of potential violations can be extracted using a Web crawler program. A Web crawler program is an automated program that follows links to visit Web sites. We developed a Java-based Web crawler program to access web pages at remote website, and to obtain the number of potential violations of Web accessibility checkpoints.

2. Measurement of other features of the website

We measured three variables — category of function, popularity, and importance of the websites — as the features of the websites. Each website falls into one of the categories defined during the sampling phase. For each website, we checked the ranking from another search engine named Alexa. The ranking of a website from the Alexa is according to the daily visiting volume of the website. To a certain extent, it reflects the popularity of the website on the Web.

We measured the level of importance based on the PageRank score of each website available from the Google™ search engine. The PageRank score relies on the uniquely hypertext nature of the Web by using its vast link structure as an indicator of an individual page's value. In essence, Google™ interprets a link from page A to page B as a vote, by page A, for page B. Therefore, the PageRank score of a page can be viewed as an indicator of the importance of the page. But the Google™ looks at more than the sheer volume of votes, or links a page receives; it also analyzes the page that casts the vote. Votes cast by pages that are themselves "important" weigh more heavily and help to make other pages "important." Because the Google™ does not provide PageRank in numerical value from its searching interface, we had to rank the sites according to PageRank score and used the ranking number as the value of the variable.

All the data were collected during February and March in year 2003.

Data Analysis

Descriptive statistics (means and standard deviation) was calculated for each variables considered in the study. Moreover, univariate statistics of the WAB scores was calculated at the level of each category. Then a one way ANOVA (ANalysis Of VAriances) test was applied to the WAB scores at the level of the website's functional category. If the ANOVA test indicates a large difference WAB score between different categories, the post hoc Bonferroni test of the WAB scores between different categories will be conducted. The

alpha level is adjusted for multiple comparisons in the Bonferroni test.

Nonparametric Spearman correlation statistics was conducted to measure the level of correlation between the WAB scores and popularity and importance of the websites.

All statistical analyses were conducted using SPSS 11.0 package.

RESULT

There are totally 122 websites listed in the Google directory. We excluded 14 websites according to our criteria of selection. The means and standard deviations of each website are calculated. Among those websites, the one with the lowest score (0.97) is the Combined Health Information Database (CHID) from NIH. The one with the highest score (24.99) is one of the community websites, discussyourhealth.com. Among the six categories, governmental websites present the lowest scores, and portal websites present the highest (table 1).

Table 1: Means and standard deviations of Web Accessibility Barrier (WAB) scores across functional categories

Category	Mean	Sites (n)	Standard Deviation
Portal	13.17	30	6.16
Government	1.42	6	.39
Corporate	9.03	25	3.94
E commerce	8.53	8	3.39
Community	9.92	29	6.8
Educational	2.06	10	1.16
Total	9.31	108	6.29

Figure 1 shows the average scores of Web accessibility for each of the Web categories and indicates the possible existence of clusters among the six categories.

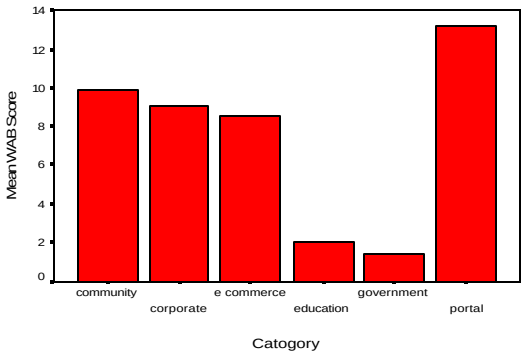

Figure 2: Means of Web accessibility barrier (WAB) score among six categories.

The ANOVA test of the WAB scores among the categories shows that there is a statistically significant difference among the category groups ($F = 9.705$, $p < 0.001$). The post hoc Bonferroni test found that the mean the WAB scores of the governmental and educational websites are significantly different from the rest of categories ($p < 0.001$). There is no difference between different categories within these two clusters.

The spearman correlation test shows that there is a statistically significant correlation between the accessibility score and the Alexa ranking, but there is no statistically significant correlation between the PageRank score and the Web accessibility score.

Table 2: Spearman correlation coefficients between Web accessibility barrier score, Alexa ranking and Google PageRank.

	WAB score	Alexa ranking	*PageRank*
WAB score	1.00	0.28**	*0.15*
Alexa ranking	0.28**	1.00	*0.32***
PageRank	*0.15*	*0.32***	*1.00*

** Correlation is significant at the .01 level (2-tailed).

DISCUSSION

Because of the legal enforcement and commercial benefits, more and more developers of health information websites are becoming aware of Web accessibility. Many evaluating and assessing tools have been available to developers intending to improve the accessibility of their Web sites. However, the current status of the accessibility of the Web, especially of health information websites, is largely unknown. Our study is the first addressing the issue and providing a relatively comprehensive evaluation on consumer health information websites. Compliance with the specifications of Web content accessibility is one of the necessary approaches to narrow the digital divide between the information affluent and digitally underserved people, in our study, the people with disabilities. The study also proposes a framework for evaluating the accessibility of a website with the consideration of both Web accessibility violations and the complexity of the website. We expect this approach to provide an accurate and complete measurement about the level of accessibility barriers than using the number of violations only.

We found that none of the consumer health information websites satisfied all of the Web accessibility requirements. These may be attributed to website developers knowing little about web

accessibility standards, lack of effective and efficient evaluation and repair tools, and the pressure of quick uploading updated information on to the website. Web accessibility is often an afterthought when Web content design is already finished. This implies that program tools addressing the post-hoc repairs of Web accessibility violations or an accessible proxy server for people with disabilities may be more acceptable from both the developers and website visitors.

It is noticeable that governmental consumer health information websites are the most accessible, and the educational websites are the second most accessible. Section 508 law should play an important role in this compliance since it is mandatory for all federal agencies. It may also indicate that legal enforcement would facilitate removal of the barriers of accessibility for people with disabilities.

However, although the governmental websites present fewer accessibility barriers to people with disabilities, but none of the websites pass the WCAG guideline priority 1 checkpoints. The most common error is "not providing alternative text for images". Because the correction of the error is relatively easy when editing Web pages, it may imply that the Web site editor simply overlook the errors. On the other hand, an automatic website monitoring program may assist the website editors to identify and correct the errors.

The educational websites are the second most accessible category of the websites. Although Section 508 is not mandatory for the information technology available on educational websites, awareness of WCAG rules and legal requirements on campus may result in the better performance of Web accessibility among educational websites.

We also found the existence of correlation between accessibility and popularity of a website. This may imply that people with disabilities are more likely to visit websites contain fewer or no barriers to them. Subsequently it will increase the overall popularity of the websites since it attracts a group of visitors who have difficulties to access other sites containing more web accessibility barriers.

Please note that there are several limitations of this study. First, although the intention of this study is to perform a comprehensive assessment of Web accessibility of a website, it is not practical for some websites, especially those with large amount of archived content. The Bobby program we used in the study often freezes when we try to examine all layers of pages of the website. Therefore, we only use a manageable two layers of Web pages in our study. A more robust tool needs to be adopted or developed in future studies. Second, we only examine the checkpoints of Web accessibility that can be examined automatically by a computer program. Many other checkpoints do need manual check of pages to ensure the compliance of the content and the guidelines of Web accessibility. We expect that the checkpoints that can be automatically evaluated will have an agreement with the manual checkpoints; therefore they can be used as the surrogate assessment for the Web accessibility of a web site. The agreement between these two groups of checkpoints needs to be tested in future study.

This study provides current state-of-the-accessibility of consumer health websites to people with disabilities. The accessibility barriers exist in all categories of the sites, especially the commercial websites. This effort is expected to bring awareness on the issues of Web accessibility among the consumer health information websites.

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References

1. Horrigan, J.B. and L. Rainie, *Counting on the Internet*. 2002, Per Internet & American Life Project: Washington D.C.
2. NTIA, *A Nation Online*. 2002, NTIA: Washington D.C.
3. Kaye, H.S., *Computer and Internet Use among People with Disabilities*, in *Disability Statistics Report*. 2000, Department of Education, National Institute of: Washington D.C.
4. Nielsen, J., *Beyond Accessibility: Treating Users with Disabilities as People*. 2001, Alert box.
5. Hayes, M.G., *Individuals with Disabilities Using the Internet: A Tool for Information and Communication.* Technology and Disability, 1998. 8(3): p. 153 - 158.
6. Eysenbach, G., *Consumer Health Informatics.* BMJ, 2000. 320: p. 1713-1716.
7. McNeil, J.M., *Americans with Disabilities: 1991-1992. U.S. Bureau of the Census Current Population Reports, P70-33*. 1993, U.S. Government Printing Office: Washington, DC.
8. Nielsen, J., *Accessible Design for Users with Disabilities*. 1996, Alertbox.
9. *Web Accessibility Initiative (WAI)*, http://www.w3c.org/wai
10. Google, http://www.google.com
11. Section 508., *http://www.section508.gov*.
12. Bobby, *http://bobby.watchfire.com*.